Leaf production and utilization in *Hyphaene coriacea*: Management guidelines for commercial harvesting

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The objective of this study was to assess *Hyphaene coriacea* leaf production in order to provide management guidelines for palm leaf harvesting. Leaves with a leaf blade length greater than 80 cm are selected for commercial basketry. Palm stems with leaf blades 80–99 cm long produced 3,15 (*S.E.* ± 0,45) leaves/year and those with leaf blades 100–119 cm long 3,79 (*S.E.* ± 0,59) leaves/year. If palm leaves suitable for basketry were harvested on a sustainable basis this would provide an estimated 140 leaves/hectare/year or approximately 2,5 million leaves/year in the study area. This is far in excess of the current level of domestic or commercial use and there appears to be a high potential for increased harvesting of this resource.

Die doel van hierdie studie was om *Hyphaene coriacea*-blaarproduksie te evalueer ten einde bestuursriglyne vir die oes van palmblare daar te stel. Blare met 'n blaarskyf-lengte van meer as 80 cm is geskik vir kommersiële mandjieswerk. Palmstamme met blaarskywe van 80–99 cm het 3,15 (*S.E.* ± 0,45) blare/jaar geproduseer, en dié met blaarskywe van 100–119 cm, 3,79 (*S.E.* ± 0,59) blare/jaar. As palmblare wat vir kommersiële madjiewerk geskik is, op 'n handhaafbare grondslag bestuur sou word, sou dit 'n geraamde 140 blare/hektaar/jaar, of sowat 2,5 miljoen blare/jaar in die ondersoekgebied produseer. Dit is ver bo die huidige vlak van huishoudelike kommersiële gebruik, en dit lyk asof daar 'n groot potensiaal vir 'n hoër opbrengs van hierdie hulpbron bestaan.

Keywords: Commercial craftwork, palm leaf production, resource management

Introduction

Palm leaves provide an important source of weaving material throughout Africa, both for subsistence and commercial needs (Ebert 1977; Malan & Owen-Smith 1974; Fleuret 1980). *Hyphaene* palm leaves are particularly useful for weaving due to their strength and length of fibre, and are frequently used because leaves are accessible from the relatively short palms.

Leaves are harvested for commercial craftwork industries in rural areas in the Sudan (*Hyphaene thebaica* Mart.) (Babiker 1982), Botswana [*Hyphaene petersiana* Klotzch, formerly *H. ventricosa* Kirk (Gibbs Russell *et al.* 1985)] (Cunningham & Milton 1987) and in South Africa [*Hyphaene coriacea* Gaertn., formerly *H. natalensis* O. Kuntze (Gibbs Russell *et al.* 1985)] (Cunningham 1987). Commercial harvesting and processing of palm leaves for fibre production has also been considered for *Hyphaene petersiana* (Fanshawe 1967) and *Hyphaene coriacea* (Moll 1972).

Despite the commercial importance of palm leaves, few data are available on palm abundance, annual leaf production, or the effects of defoliation of palms. Yet knowledge of these factors is necessary if these resources are to be managed on a sustainable basis. This is evidenced by the over-exploitation of palms that has taken place elsewhere due to a high frequency and/or intensity of leaf exploitation (Fleuret 1980; Babiker 1982; Cunningham & Milton 1987).

The objective of this study was to provide an assessment of *Hyphaene coriacea* leaf production in order to provide a basis for management of leaf harvesting for rural craftwork industries in the same area surveyed by Moll (1972) in Maputaland, South Africa (Figure 1).

Methods

Leaf production

Fanshawe (1967) derived his data on leaf production in *Hyphaene petersiana* from counts of leaves produced in the period between successive annual flowering seasons. This could not be done in an area where palms seldom reach flowering maturity due to frequent palm wine tapping (Cunningham 1985), as it is the leaves of these immature palm stems that are used for basketry. Use of Fanshawe's (1967) method would also have led to an overestimate of annual leaf production and an underestimate of the current level of annual leaf harvesting as large palms produce more leaves but these are inaccessible and are rarely cut.

It was also not practical to differentiate palms on the basis of stem height as Fanshawe (1967) did with 'juvenile' *Hyphaene petersiana* palms, or to use basal diameter of the stem or the fibrous base of the coppicing stems. Stems that recover from tapping [13,8% of tapped stems sampled (Cunningham 1985)] are short, but were observed to have a high rate of leaf production probably due to the carbohydrate reserves of the palm stem base. Stem height or basal diameter were not used as a means of distinguishing palms of different sizes and possibly differing rates of leaf production due to the stunting effects of palm wine tapping on the palms.

Field observations, discussions with local people and measurements of leaf blades cut by craftworkers (Cunningham 1985) confirmed that few leaf blades shorter than 80 cm were cut for domestic or commercial purposes. It was also known from work by Fanshawe (1967) that leaf size and the rate of leaf production increased with palm age. For these reasons, leaf blade length was chosen as the most suitable way of distinguishing palm stems in the study area.

Two study sites were selected on the basis of ease of access and relocation. On the basis of field observation and the quantitative survey by Moll (1972), these sites were considered to be representative of the high palm density area where commercial harvesting would probably take place. Sixteen palm stems were marked with numbered stakes at site A (August 1981) and 34 palm stems at site B (October 1981). The majority of the palm stems selected had leaf blades in size classes greater than 80 cm as this was the size most used by craftworkers.

Partially emerged leaf blades were included in the calculation of annual leaf production as a fraction of the blade length of a fully grown leaf. Leaf blade length was measured from the centre of the rosette of tightly packed petioles to the tip of the leaf blade. Where more than one

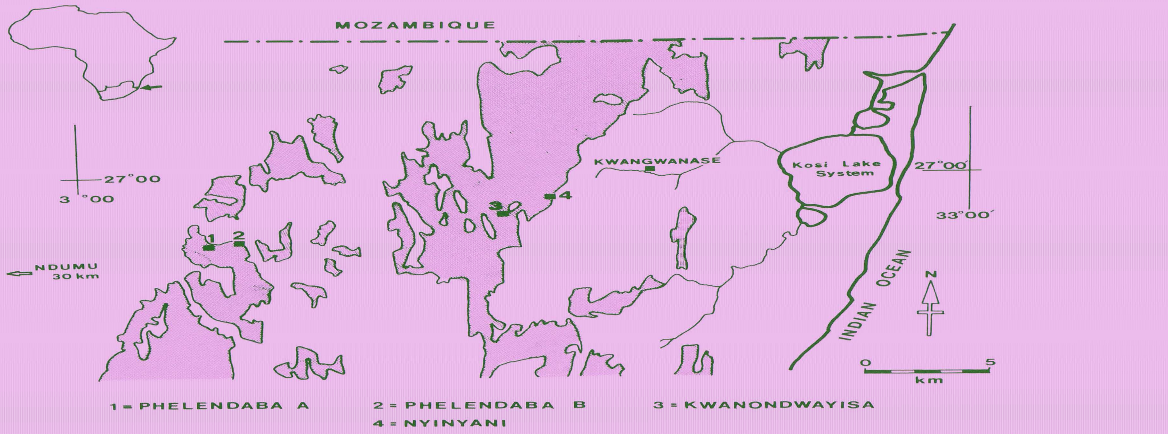

Figure 1 Map showing the distribution of sampling sites within *Hyphaene coriacea* palmveld (Loxton *et al.* 1969) in the study area.

unopened leaf was present (i.e. in larger palms) the sum of the fractions of partially emerged leaf blades was often greater than one mature leaf.

Leaf utilization

The measurements of *Hyphaene coriacea* leaf production showed that 2–5 leaves are produced annually per stem, dependent on palm or stem size. Large (> 80 cm) leaf blades suitable for weaving are generally produced by large palms or stems. This provided a more accurate basis for field assessment of leaf utilization than the estimate made by Moll (1972) who considered that only one leaf was produced per stem per year. Each palm produces a succession of leaves in a spiral around the apical meristem. These remain on the stem for over 2 years, with the leaf blade deteriorating to leave the petiole persisting on the stem. Only the unopened leaf (Figure 2) at the centre of the spiral is supple enough for use. When the petiole of the large shoots are cut this leaves a clear-cut surface easily distinguishable from the ragged leaf damage due to insects or browsing by cattle. The persistent petioles and leaves arranged around the stem therefore represent a past history of leaf harvesting for each individual palm stem. The number of stems per clump was recorded, but each stem was treated as a separate plant. Leaves of these stems were divided up into different size classes according to the length of the leaf blade of the youngest open leaf. Measurements were made from the point where the petiole and leaf blade meet to the tip of the middle leaf blade segment (Figure 3). When this point was oblique, the measurement was taken from the lowest point of the leaf blade.

Large palms produce more leaves per year (Fanshawe 1967). The number of leaves of each stem that were examined to determine the level of annual leaf harvesting therefore varied according to leaf blade length. These were

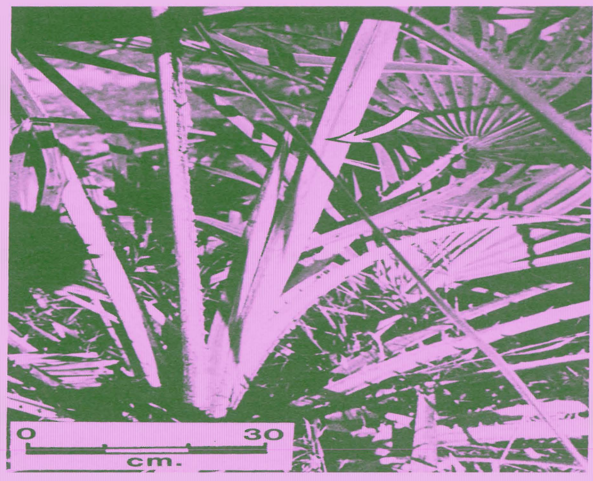

Figure 2 Two unopened leaves at the centre of a spiral of mature leaves. Only the large unopened leaf blade (indicated by the arrow) would be cut for weaving purposes.

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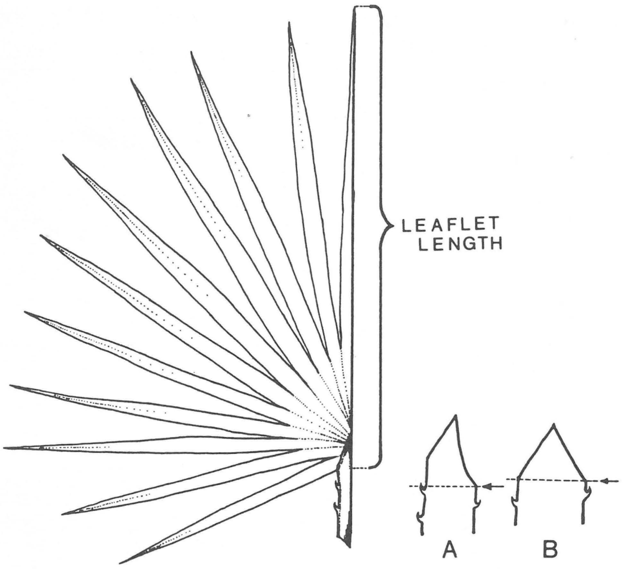

Figure 3 Section of a mature *Hyphaene coriacea* leaf showing the point from which leaf blade length was measured in the case of 'normal' and oblique points where the petiole and leaf blade meet.

Table 1 Annual leaf production

Size class (cm)	Sample size (leaves/stem)
0–39	2
40–79	3
80–119	4
120–179	5

based on measurements of annual leaf production as shown in Table 1.

The extent of leaf harvesting was assessed at four different sites in the study area adjacent to the KwaNgwanase–Ndumu road at varying distances from the village of KwaNgwanase (Figure 1). Plot size used at Nyinyani, KwaNodwayisa and Phelendaba site B was 50 × 50 m but at Phelendaba site A a smaller plot size (20 × 20 m) was used due to the high palm density at this site. All palm stems within each plot were inspected for leaf damage and measurements were made of leaf blade length. Leaf blades of a length particularly favoured for basketry (> 90 cm) were selected at random in the high palm density area to assess the level of leaf harvesting to test field observation that only a small percentage of available leaves were cut.

Results

Leaf production

Monthly measurements of leaf growth in the marked palms showed that leaves are produced throughout the year. Although variable, the palm stems with longer leaf blades (i.e. larger palms) produced more leaves per year. Palm stems with leaflets in the 80–99 cm size class produced 3,15 (*S.E.* ± 0,45; n = 10 stems) leaves per year and those in the 100–119 cm size class 3,79 (*S.E.* ± 0,59; n = 17 stems) leaves per year. Smaller palm stems with leaves 40–59 cm long produced 2,18 (*S.E.* ± 0,48; n = 10 stems) leaves per year. Unfortunately the largest of the palms selected for study were cut down for palm wine tapping 3 months after they were marked, reducing the number of palms in the sample.

Leaf blade size classes and leaf use

Leaf blade size class distribution and the intensity of annual leaf utilization varied considerably in the study area. Palms with shorter leaf blades dominated the Phelendaba sites (Plots A and B) whilst at KwaNondwayisa and Nyinyani there were more larger leaves in the sample populations (Table 2; Figure 4). The percentage of leaves in the sample populations with a leaf blade length suitable for weaving (i.e. > 80 cm) was higher at these sites (Table 3). At all sites the largest leaf blade size classes were selected (Figure 5). These larger size classes were under the highest intensity harvesting. Leaf blades longer than 140 cm (which only occurred at Phelendaba B) were under the heaviest exploitation. At Nyinyani, where palms grew at a far lower density, cutting was more selective for the large size classes available, but a wide range of size classes was used (Figure 5).

Intensity and frequency of leaf use

The intensity and frequency of annual leaf utilization were low throughout the sample sites. This was highest at Nyinyani, lower at KwaNondwayisa and lowest at Phelendaba A. No leaves in the sample population at Phelendaba A had been harvested over the past year (Table 2). Only two leaves (0,5% of annual leaf production) of the 102 palms with leaf blades > 90 cm sampled at random had been harvested. Leaf damage by insects and cattle was negligible. Although opened leaves are suitable for fibre production (Fanshawe 1967; Moll 1972) the only use of mature leaves was for weaving the shade caps (*iziKhapelo*) for tapped palm stumps. Frequency and intensity of cutting were low even in the palmveld next to the road close to KwaNgwanase (Nyinyani sample site) where the level of leaf utilization was 8% of annual leaf production (Table 4).

Discussion

In the study area, palm wine tapping and leaf utilization represent two conflicting uses of *Hyphaene coriacea* (Cunningham 1985). This affects management proposals for leaf harvesting as leaf availability would appear to depend on: (a) rate of leaf production (b) density of palm stems (c) stem size (or age) class selected for palm wine tapping (d) destructiveness of the tapping technique (e) frequency of defoliation (f) intensity of defoliation.

Hyphaene coriacea leaves are one of the few plant resources in the study area where implementation and management of increased commercial utilization is relatively uncomplicated (Cunningham 1985). Firstly, the palms are abundant (Moll 1972) and resilient to defoliation, recovering even after severe defoliation and damage resulting from palm wine tapping (Cunningham 1985). Secondly, although the palmveld is a communally owned multiple-use area, it is divided into 'tapping concession areas' which are under tribal control and allows palm wine tappers to have individual rights to palms for tapping (Cunningham 1985). This provides a culturally acceptable basis for resource harvesting based on individual rights to the palm resource and a possible solution to the 'tragedy of the commons' with respect to palm leaf utilization. Thirdly, the method described in this paper is a practical way of assessing the level of annual leaf exploitation. Finally, there is a market for palm leaves throughout Natal, both for commercial craftwork and for domestic purposes (Cunningham 1985).

In common with *Hyphaene petersiana* (Fanshawe 1967), *Hyphaene coriacea* leaves are produced throughout the year. Leaf size, weight and production increases with palm age (Fanshawe 1967) and presumably with the amount of carbohydrate reserves in the palm as Mason & Hutchings (1967), Schuster & George (1976) and Austin & Urness (1980) found in dicotyledonous woody plants. Leaf production in *Hyphaene coriacea* was higher than the average of

Table 2 The percentage of leaves harvested, leaf size class distribution and number of stems in each size class at the four study sites

Site	Category	Leaf size class (cm) 0–19	20–39	40–59	60–79	80–99	100–119	120–139	140–159	160–179
Phelendaba A (n=196 stems)	Stem number in size class	1	34	90	55	25	3	0	0	0
	Number harvested	0	0	0	0	0	0	–	–	–
	Leaf number damaged by insects or cattle	0	0	0	0	0	0	–	–	–
	Percentage of annual leaf production in size class harvested	0	0	0	0	0	0	–	–	–
Phelendaba B (n=305 (stems)	Stem number in size class	5	53	65	94	63	20	3	1	1
	Number harvested	0	0	0	0	0	0	0	1	1
	Leaf number damaged by insects or cattle	0	0	0	1,5	1	1	0	0	0
	Percentage of annual leaf production in size class harvested	0	0	0	0	0	0	0	20%	16,7%
Kwa-Nondwayisa (n=205 (stems)	Stem number in size class	0	1	32	64	84	24	0	0	0
	Number harvested	–	0	0	1	5	3	–	–	–
	Leaf number damaged by insects or cattle	–	0	0	0	1,3	0	–	–	–
	Percentage of annual leaf production in size class harvested	–	0	0	0,5%	1,9%	3,3%	–	–	–
Nyinyani (n=132 stems)	Stem number in size class	2	5	15	33	59	16	2	0	0
	Number harvested	0	0	1	2	11	8	2	–	–
	Leaf number damaged by insects or cattle	0	0	0	0,5	2	0	0	–	–
	Percentage of annual leaf production in size class harvested	0	0	2,3%	2,0%	4,7%	13,2%	20%	–	–

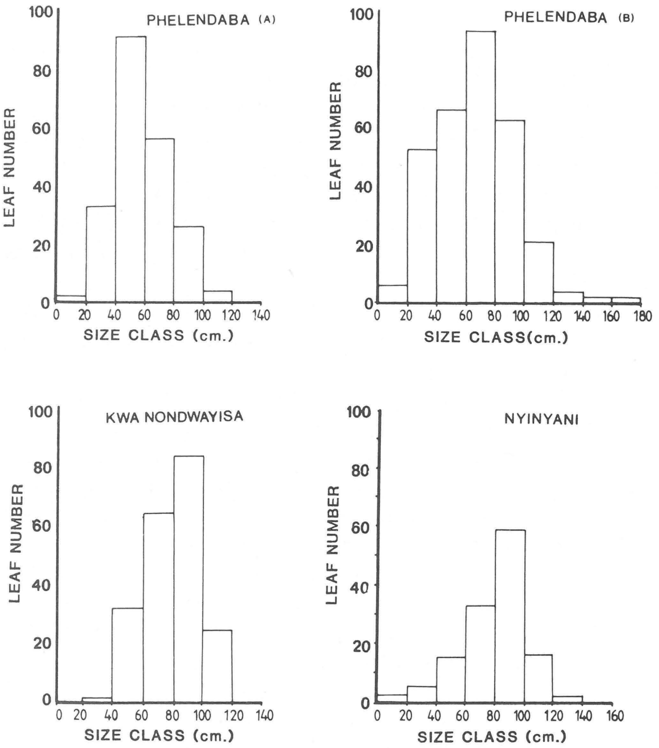

Figure 4 Leaf blade size class distribution at four sites in the study area: Phelendaba A (n = 196 stems), Phelendaba B (n = 305 stems), KwaNondwayisa (n = 205 stems) and Nyinyani (n = 132 stems).

one leaf/stem/year estimated by Moll (1972) and although variable, increased with palm size and age.

The structure of the palmveld appears to have been changed from palmveld dominated by tall palms to the

Table 3 The percentage of *Hyphaene coriacea* stems in each sample population bearing leaves of a suitable size for basketry

Leaflet size class	Site sampled: Phelendaba A (n=196)	Phelendaba B (n=305)	KwaNondwa-yisa (n=205)	Nyinyani (n=132)
80–99	12,8	20,6	41,3	44,7
100–119	1,5	6,7	11,8	12,1
120–139	0	1,0	0	1,5
140–159	0	0,3	0	0
160–179	0	0,3	0	0

present high density of short, multi-stemmed palms due to the destructive nature of the palm wine tapping technique. However more than 80% of a sample of 166 *Hyphaene* palms tapped in the study area recoppiced after tapping (Cunningham 1985). An increase in number of coppice stems would increase the number of leaf-producing stems and the potential for a higher leaf production per hectare. Increasing tapping intensity has reduced the number of large stems that would have a higher rate of leaf production however. Palm wine tappers currently select stems with a leaf blade size longer than 100 cm. Probably due to low palm wine yields and income (Cunningham 1985), tappers are concentrated in high palm density areas to enable them to tap as many palms as possible per unit time. This is particularly the case in areas close to palm wine marketing points and probably accounts for the smaller leaf blade size classes at Phelendaba A and B sample sites (Figure 4). Sample sites with a low palm density further away from palm wine marketing points, had larger palms with larger leaf blades in their sample populations (Table 4).

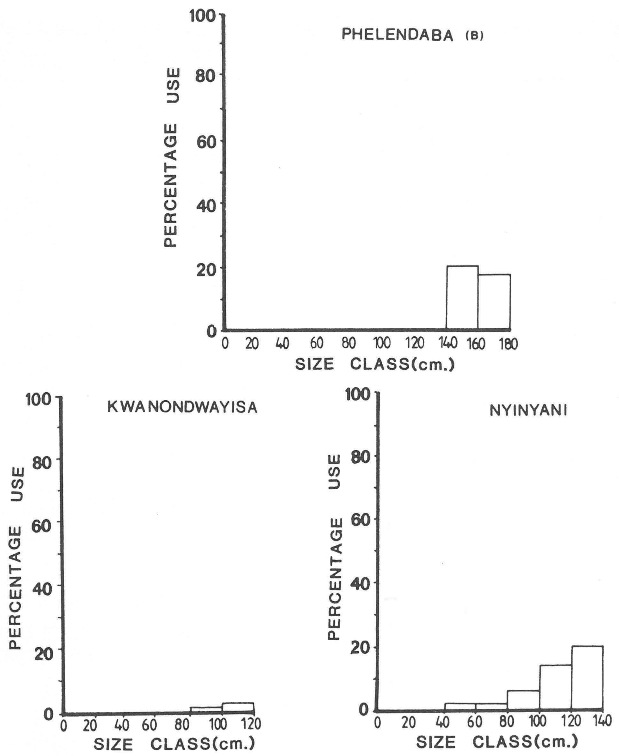

Figure 5 The percentage use of annual leaf production in each *Hyphaene coriacea* leaf blade size class at the three study sites where utilization was recorded.

Table 4 The decrease in level of leaf utilization with increase in distance away from the main village (KwaNgwanase) and decrease in large palms as palm density and palm wine tapping intensity increase

	Phelendaba A (n=196 stems)	Phelendaba B (n=305 stems)	Kwa-Nondwayisa (n=203 stems)	Nyinyani (n=132 stems)
Palm density (palms ha^{-1})	467	71	49	22
Stem density (stems ha^{-1})	858	203	207	66
Percentage of leaflets more than 100 cm	1,5	8,2	11,8	13,6
Percentage of annual leaf production harvested	0	0,6	1,9	8,3
Distance from village (km)	24	23	17	8

Although palm size and leaf production are kept at a low level by tapping, leaf availability is high due to the extensive area and high density of the palmveld. Approximately 25 600 ha of palmveld cover the study area and 17 600 ha of this would be practical for local people to harvest. The average palm density of this area recorded by Moll (1972) is at least 91,4 palms ha^{-1} yr^{-1} (483,6 stems ha^{-1} yr^{-1}) as Moll (1972) sampled low palm density areas mapped by Loxton *et al*. (1969) as grassland and included these in his calculations of *Hyphaene coriacea* abundance.

Rational management of the leaf resource is facilitated by the (a) restriction of leaf use to large size classes (Figure 5) (b) selective cutting of leaves that minimizes damage to other leaves on the stem (c) low level of palm destruction to obtain the edible meristem and young leaf bases of the palms ('palm hearts') which is common in Botswana (Cunningham & Milton 1987).

This study has documented the low level of leaf harvesting in the study area. The other extreme is the overexploitation of *Hyphaene thebaica* (Babiker 1982) and *Phoenix reclinata* Jacq. (Fleuret 1980) leaves for basketry and extensive defoliation of *Hyphaene petersiana* where over 40% of annual leaf production was either cut or damaged by non-selective cutting with hoes (Cunningham & Milton 1987). In the long-term, the reduction in the availability of leaves for commercial and domestic use benefits neither the resource nor the resource users.

Sustainable use of renewable resources avoids this situation and is recognized as a justifiable objective for conservation and development (IUCN 1980). Selection of a suitable harvesting regime is an essential consideration prior to sustainable commercial use of palm leaves. Management of the palm leaf resource involves a balanced relationship between leaf harvesting, palm wine tapping and leaf production. Exhaustion of non-structural carbohydrate reserves is generally accepted to result from excessive defoliation of plants, causing a reduction of plant vigor and productivity. Harvesting of all *Hyphaene petersiana* leaves apart from the unopened leaf blade reduced the mean number of leaves produced per palm and their mean weight (Fanshawe 1967). As a basis for *Hyphaene petersiana* leaf harvesting for fibre, Fanshawe (1967) suggested a proportional cut of 50% of leaf production every 6 months or alternatively a 100% cut every year. This is not feasible for *Hyphaene coriacea* as only unopened leaves are cut. This intensity and frequency of leaf removal would also appear to be excessive for both perennial monocotyledonous (Miller & Donart 1981) and dicotyledonous woody plants (Lay 1965; Buwai & Trilica 1977) and is not recommended for *Hyphaene coriacea*.

Management recommendations

Managed commercial harvesting to provide an optimal sustainable yield would increase the income to local people from the palmveld. This would provide added justification for maintenance of the palmveld in as near natural state as the multiple-use area recommended by Tinley & van Riet (1981) rather than for afforestation suggested by Loxton *et al*. (1969). The support of the local people and the Tribal Authority are essential to achieving this objective. The following suggestions are made towards achieving the objective of sustainable use:

(a) Until more detailed information is available, *Hyphaene coriacea* leaf harvesting should be limited to cutting every third leaf (i.e. approximately 30% of annual leaf production). At this rate of defoliation a conservative estimate of the number of leaves that would be available for harvesting is shown in Table 5. This is based on the stem density of 483,6 stems/hectare (Moll 1972) at a leaf production rate of 3,15 ($\pm$ 0,45) leaves/stem/year for the 80–99 cm size class and 3,79 ($\pm$ 0,59) leaves/stem/year for the 100–119 cm size class in the palmveld area mapped by Loxton *et al*. (1969). This is far in excess of the existing rate of commercial use (Table 5). Assuming that 20% of the leaflets in the population are in the 80–99 cm size class and 10% are more than 100 cm under the current level of palm wine tapping, this would give an average production of nearly 2,5 million leaves/year in the study area (Table 5).

(b) Selective cutting using bush knives should continue as is currently practised.

(c) Basket weaving should preferentially take place locally to obtain maximum economic benefit locally from leaf use rather than have the raw materials (leaves) exported out of the area.

Table 5 The estimated leaf production (leaves ha^{-1} yr^{-1}) and the number of leaves available for harvesting under different rates of palm wine tapping. The availability of leaves is based on the assumption that every third leaf is cut and 10 leaves ha^{-1} yr^{-1} are used for subsistence purposes or are damaged

Category	Size class (cm)	Percentage of leaves in required size class in *Hyphaene* population 10%	20%	30%	40%	50%	60%	70%
Annual leaf production (leaves ha^{-1} yr^{-1})	80–99	152,3 (±21,7)	304,7 (±43,5)	457,0 (±65,3)	609,3 (±87,0)	761,7 (±108,8)	916,0 (±130,6)	1 066,3 (±152,3)
	100–119	183,3 (±28,5)	366,5 (±57,1)	549,9 (±85,6)	733,1 (±114,1)	916,4 (±142,7)	1 099,7 (±171,2)	1 283,0 (±199,7)
Number of leaves available for harvesting (leaves ha^{-1} yr^{-1})	80–99	50,3 (±7,2)	100,6 (±14,4)	150,8 (±21,5)	201,1 (±28,7)	251,4 (±35,9)	302,3 (±43,1)	351,9 (±50,3)
	100–119	60,5 (±9,4)	120,9 (±18,8)	181,5 (±28,2)	241,9 (±37,6)	302,4 (±47,1)	362,9 (±56,5)	423,4 (±65,9)
Number of leaves available for commercial use (leaves ha^{-1} yr^{-1})	80–99	40,3 (±7,2)	90,6 (±14,4)	140,8 (±21,5)	191,1 (±28,7)	241,4 (±35,9)	292,3 (±43,1)	341,9 (±50,3)
	100–119	50,5 (±9,4)	110,9 (±18,8)	171,5 (±28,2)	231,9 (±37,6)	292,4 (±47,1)	352,9 (±56,5)	413,4 (±65,9)
Total available annually for commercial harvesting (leaves ha^{-1} yr^{-1})	80–99	709 280 (±126 720)	1 594 560 (±253 440)	2 478 080 (±378 400)	3 363 360 (±505 120)	4 248 640 (±631 840)	5 144 480 (±758 560)	6 017 440 (±885 280)
	100–119	888 800 (±165 440)	1 951 840 (±330 880)	3 018 400 (±496 320)	4 081 440 (±661 760)	5 146 240 (±828 960)	6 211 040 (±994 400)	7 275 840 (±1 159 840)
Combined value of crop (R ha^{-1} yr^{-1})		R9,00	R20,15	R31,23	R42,35	R53,38	R64,52	R75,53

It is unlikely however that the entire quantity of leaves that could be harvested would be used locally, as the local craftwork project which is supplied by about 500 people, is only using about 10 000 to 11 000 leaves/year (Cunningham 1987).

(d) The excess of leaves should be dried and then transported elsewhere in Natal, for commercial or domestic use, possibly through existing craftwork organizations to people with weaving skills but a lack of weaving material.

(e) There are two alternatives for management of leaf harvesting. Both need the support of the Tribal Authority.

(i) Harvesting by the palm wine tappers who would be given individual rights to palm leaves in addition to being able to tap palms lying within the areas designated by the local tribal policeman or headman.

The main advantages to this are firstly, that it would reduce the opportunistic scramble for a common property resource (palm leaves) with an economic value and at the same time improve the income of the palm wine tappers (Cunningham 1985). Secondly, it would spread the demand for leaves throughout the area (as palm wine tappers are tapping palms through most of the palmveld) and reduce the probability of local overexploitation in easily accessible sites.

(ii) Harvesting by a group of people employed to harvest leaves throughout the area and under the control of the local management organization.

(f) All commercial harvesting and sales of processed (i.e. woven) or unprocessed leaves should be co-ordinated through a local resource management organization in order to control leaf utilization. The Tribal Authority, the local craftwork marketing organization and the conservation body should be represented in this group.

(g) Plots should be set up to study palm leaf production under different intensities and frequencies of defoliation and to take site factors (particularly varying edaphic conditions) into account in order to update management proposals.

(h) Research work needs to be done on nutrient input and export from the palmveld area to determine whether export of leaves would result in nutrient depletion (e.g. N, P) and ultimately a decline in productivity of the vegetation.

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